Polariton correlations and polariton dynamics in fiber-coupled atomic ensembles

In the Rauschenbeutel group, we recently demonstrated trapping of laser-cooled atoms using optical nanofibers, i.e., glass fibers with a diameter smaller than the wavelength of the guided light. The trap relies on the force exerted by the evanescent field surrounding the nanofiber and confines the atoms 200 nm above the nanofiber surface [1]. In addition to trapping the atoms, the nanofiber allows us to efficiently interface the atoms with further light fields via the evanescent field. We now plan to employ such a fiber-coupled atomic ensemble in order to explore a new regime of light-matter interaction: Under certain conditions, photons propagating through the fiber can no longer be considered as independent entities but result in collective atom-light excitations, so-called dark state polaritons. These excitations behave like massive particles that repel each other. As a consequence, a number of solid state phenomena can be realized in this model system. In particular, the polaritons can crystallize. If one then transforms them back into photons, these should leave the fiber like beads on a string, corresponding to a highly non-classical state of light. The goal of the PhD project is to implement such strongly interacting polaritons and to study their dynamics and correlations.

[1] E. Vetsch, D. Reitz, G. Sagué, R. Schmidt, S. T. Dawkins, and A. Rauschenbeutel, *Optical interface created by laser-cooled atoms trapped in the evanescent field surrounding an optical nanofiber*, http://arxiv.org/abs/0912.1179